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A STUDY TO DETERMINE THE PRESENT AND FUTURE VALUE OF WATER FOR INDUSTRIAL USE IN THE KANSAS BASIN IN KANSAS

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Industrial plant location is evaluated in the Kansas Basin with respect to water supply and waste treatment. Individual industry requirements for water quality can vary from those standards more rigid than drinking water to toleration of water quality approaching sewage. Industrial wastes in this area were similar to domestic wastes handled by conventional means in municipal plants. The two methods used for industrial water evaluation include one based on the value of water delivered to the plant intake, the other on the value of the water to dilute the remaining waste to drinking water standards after all available treatment methods have been completed.

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A Study to Determine the Present and Future Value of Water for Industrial Use in the Kansas Basin in Kansas.

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August 1, 1959

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CONCLUSIONS

1. Data are presented which indicate that the value of intake water for use by industry may have a value as high as $61,600 per acre foot diverted for use. Typical industries which are at present operating in the basin were surveyed and data for each are presented.

2. Water to be used for waste control purposes beyond conventional waste treatment is also needed in the area. Existing industries were investigated to become familiar with these wastes. Data on the quantity and value of diluting water are presented. This water may have a value approximating $2,000,000 per cfs of stabilized or quaranteed flow.

3. Conferences with various state agencies and private firms were held to determine the needs or requirements of industries in order to estimate future demands upon the basin water supply. Factors which govern plant location were investigated and existing industrial locations were compared with these factors to attempt to establish their validity.

4. Before absolute values can be established, further investigation in the economic and social areas should be made. Careful studies of demands and potential markets for the products manufactured in the area must be made.

ACKNOWLEDGMENTS

Office space, clerical help, and complete access to records were provided by the Division of Sanitation, Kansas State Board of Health.

The Kansas Water Resources Board furnished much data, both published and unpublished from its files. This data was extremely useful in developing flow capabilities in the area.

The Kansas Industrial Development Commission through its Economic Analyst provided data in regard to products manufactured and their values.

In particular the publications of the following federal agencies were reviewed and used as source material in this study; the Corps of Engineers, the Geological Survey, the Bureau of Reclamation, the Bureau of Mines, the Census Bureau, and the Public Health Service. State of Kansas agencies supplying data were: the University of Kansas, Kansas State University, Division of Water Resources of the State Board of Agriculture, the Industrial Development Commission, the Water Resources Board, and the Division of Sanitation, Kansas State Board of Health.

In many cases material abstracted from the above agencies has been used without specific reference; but an attempt has been made to include in the bibliography all pertinent material.

INTRODUCTION

Industry or business can survive only where water is available or adequate in quantity and quality. At present the Kansas Basin does not have representatives of the larger water users such as the steel or rayon industries. Until World War II (1941-45), industry in the Kansas Basin was largely restricted to basic processers of agricultural products. These industries were meat packing plants, egg and poultry plants, wheat and flour mills, milk and milk product plants, and canneries.

World War II brought into the basin non-agricultural industries. Basically the industries were munitions and war material ones; but their success opened the door to non-agricultural enterprises. Since the munitions plants were representatives of the chemical industry, and because they were successful, chemical plants have since located in the area. The war effort bought representatives of other industries in contact with this area. These representatives then prevailed upon their companies to investigate this area for plant locations.

Since 1950, over 125,000,000 dollars worth of new industrial building has taken place in this basin. The largest share of this new building has been by chemical or allied firms. In attempting to evaluate the water resources potential of an area for industrial expansion, it is difficult to find adequate criteria for such evaluation. The amount of activity is continually changing. It changes with season of the year, with new product development, with new processes to produce old-known products, and with changing economic conditions of the area and the nation as a whole.

Consequently, estimation of present industrial water demand is difficult and the estimation and evaluation of future demands becomes an almost impossible task.

Factors which govern industrial plant location can be summed up as follows:

(1) Nearness to raw materials and markets.

(2) A good supply of water, electricity, gas, and other utilities.

(3) The wastes can be treated economically and discharged in such a manner so as not to violate river tolerances.

(4) Good transportation facilities available.

(5) Good labor sources, i.e. skills needed are in the area, with records of good workmanship, community pride, and with good education levels.

(6) A high rating of schools, churches, recreational facilities, stores, housing, etc.

Probably no one site provides the desired optimum in all six categories, so that plant location will be such that the overall maximum is achieved. Personal judgment and prejudice probably enter into the picture. Items (2) and (3) are the subjects of this investigation.

Good water, item (2), must be considered from both a quality and quantity viewpoint, the quantity needed for the enterprise must be forthcoming; but large variation exists within an industry. If the overall sum of the above six items is a maximum for a given location, but water quantity is low, it has been demonstrated that industry will find a way to succeed on a low water budget. Quality is in somewhat the same light; however, this is usually of more significance.

Certain undesirable constituents may completely rule out the use of water for a certain enterprise. In general, if the water meets drinking water standards, it is acceptable to industry. There are some industries, however, in which the quality standards are more rigid than those for drinking water. In other cases a water quality approaching that of sewage can be tolerated. All these factors complicate the economic analysis of water supply.

The waste problem, item (3), was not generally well recognized in this area. This was probably due to a relative low level of industrial development, and the fact that in most cases the industrial wastes were similar to domestic sewage which could be handled by conventional means in municipal plants. Many of the older industries were dry industries, such as metal-working plants of small size. Now, however, industries are being attracted or sought which produce inorganic, or other wastes which cannot be treated by conventional means, or by no known economical means, and dilution of these wastes to tolerance levels for drinking water or other industrial use is required.

Two methods of evaluating industrial water value will be shown in this paper. One is based on the value of water delivered to the plant intake, the other upon the value of the water to dilute the remaining waste to drinking water standards after all economic treating methods available had been completed.

DATA AVAILABLE FOR STUDY

Most of the data analyzed in this study is already on file with various agencies. The following table lists the data and the appropriate agency which furnished it.

Data	Source
Water Use	Division of Sanitation Kansas State Board of Health
	Division of Water Resources Kansas State Board of Agriculture
Waste Products	Bureau of Mines Department of Interior
	Division of Sanitation Kansas State Board of Health
Product Produced and Value	United States Census Bureau
	Kansas Industrial Development Commission
Raw Materials	Division of Sanitation Kansas State Board of Health
Stream Flow Data	Geological Survey, Department of Interior
	Kansas Water Resources Board
Proposed Water Storage Projects	Corps of Engineers
	Bureau of Reclamation
	Kansas Water Resources Board

In addition to the above filed information, personal interviews with industrial managers were conducted by the writer to augment this filed data.

PLANT WATER INTAKE

The sources of industrial water in the Kansas Basin vary with the size of plant, its location, and the nature of the process. In most cases, the smaller plants obtain their water from public or municipal systems. The larger plants usually have their own systems. The bulk of present industrial use is in the eastern or lower part of the basin.

Although industrial water requirements are high, they greatly exaggerate industry's part in using the basin's available water supply. Nearly 95% of the water used by industry is non-consumptive. In spite of the high non-consumptive use of water, its importance cannot be lightly assessed. Large quantities must be available. Table I compares the use or demand for water and the percentage actually consumed or withdrawn from further use in the basin.

Table I

Industry	Use per unit (gals)	% Actually consumed or withdrawn from further use.
Electric Power (Kwh)	80	1.3
Meat Packing (ton)	72	7
Dairy Products (ton)	220 - 680	3
Cement Manufacturing (ton)	750	60
Oil Refining (bbl)	770	3

The above figures are national averages but the Kansas Basin averages are within the ranges shown.

The matter of quality, while not a major factor in this study, is a matter of consideration. Quality records are available for the Kansas Basin dating from 1892. They have been published by the Division of Sanitation, Kansas State Board of Health. The Bureau of Reclamation also has collected data at selected stations but its records are not so complete. With a few exceptions, the quality of the water is good.

TABLE II

Plant	Product	Water Demand		Employed	Value of Product		Valve Added*		Val.Add. Nat'l Ave. Use Basis	Kansas Average Rt. Basis
		Filed Right Ac.Ft.	Actual Use Ac.Ft.		As Shipped ,000's	Added in Basin ,000's	per ac.ft. of right	per ac.ft. of use		
Goodyear Tire and Rubber	Tires	15,829	3250	1900	$400,000	$200,000	$12,600	$61,600	$5,358	2.35
E.I. Dupont	Cello-phane	3200	1290	600	25,000	12,500	3,910	9,700	1,115	3.5
Callery Chemical	Boron Fuels	From municipal plant @ Lawrence Kansas	150	300	Unknown	1,000**	-------	6,667	No basis for est.	------
Coop Farm Chemicals	Nitrogen Fertil-izers	2419	-----	500	------	5,000	2,065	-----	1,115	1.85
Lone Star Cement	Portland Cement	199	300	205	6,750	4,000	20,100	13,330	4,718	4.24
Nemaha Coop Creamery	Butter, Milk Products	138	280	100	-----	2,500	18,100	9,000	7,605	1.2
Hill Pack-ing Co.	Meat Pro-ducts	1120	----	320	5,000	3,000	2,680	----	7,605	0.357
Lawrence Paper Co.	Paper board	----	1,000**	375	2,000	1,000	-----	1,000	939	1.06
Phillips Petroleum Co.	Oil & Assoc. Products	----	5400	13,000	157,000	110,000	-----	20,400	564	362.0

* See Appendix V

** An estimate.

Table II shows data for a few representative industries in the Kansas Basin.

Using the data from Table II, the following valuation for water was computed. Using the values under "Value added" it would seem that $10,000 per acre foot diverted would be an average or mean value. If a minimum flow of 1,000 cfs could be assured 98% * of the time, then the absolute minimum quantity of water which would be delivered to the lower river would be approximately 700,000 acre feet. This is considerably less than the lowest annual flow recorded. (1,000,000 Ac. ft. in 1934 @ Topeka.) If this water has a value of $10,000 per acre foot, its total worth would be $7,000,000,000 if the resource could be ultimately developed to this average value.

This, of course, implies proper treatment so that quality will be maintained for all downstream users.

* Based on studies of the Kansas Water Resources Board.

WASTE WATER DEMANDS

In the previous discussion attempts were made to place a value upon water diverted in manufacturing a product. In this section an attempt will be made to relate production to waste dilution necessary after all treating processes have been completed.

In order to develop permissable waste loads for the river, it was necessary to study existing quality records to determine the initial quality of the water. This was done by studying the records of the U. S. Geological Survey, the Bureau of Reclamation, and the Kansas State Board of Health. For a general picture, the Kansas Basin in Kansas can be broken into three areas. The western one-third has water of generally good quality, both mineral and bacterial, but it is of limited quantity. The middle one-third has a greater quantity, but the quality is lower. The mineral content is high due to inorganic pollution from natural salt and gypsum bed out crops. The eastern one-third is good.

For a constant level of industrial output, the production of wastes will also be constant; therefore, the stream receiving the treated wastes must have some degree of constant flow. The natural flow of the Kansas River fluctuates widely. The range of fluctuation at Topeka, at which point the river has a drainage area of 56,710 square miles has been from 112 cfs to 478,000 cfs within an eleven year period. The problem of quantity in this area is stabilization of flows. This can be achieved by a reservoir system.

TABLE III

Industry	Value Added By Industrial Operation	Waste Contributed		Acceptance Tolerance Level *See Appendix	Flow Required for dilution per unit, cfs	Value of lcfs if used for dilution of waste ion	Present ion concentration in River.
		Ion	Amount & Unit				
E. I. Dupont	$12,500,000	SO_4^{--}	50 tons/day	250 ppm	2.5/ton	$100,000	100 ppm
Coop Farm Chemicals	5,000,000	NO_3^-	0.60t/day	90 ppm	4.3/ton	1,940,000	5.0 ppm
Callery Chemical	1,000,000	B^{+++}	0.225t/day	0.3 ppm	1850/ton	2,400	0.1 ppm
Phillips Pet. Co.	110,000,000	Phenol	0.012t/day	1.0 ppb	370,000/ton	24,800	0
Nemaha Coop Creamery	2,500,000	BOD	4000 p.e.	See Criteria	2.0 cfs with Sec. Treat.	1,250,000 / $3,317,200	See Criteria

Note: No Data available on Cl^- Wastes. (See Discussion on oil field waste problems)

Sample calculations in Appendix.

The following constants were used in this study;* that about 0.50 cfs of flow of water carrying 5.0 ppm of D. O. content is needed to stabilize the wastes of 1,000 population which has been subjected to primary and secondary treatment. That about 1.50 cfs of water of the above quality is needed to handle the primarily treated wastes of 1,000 population. That 1,000 acre feet of storage in the planned completed, or reservoirs under construction in this basin (authorized projects only) will yield 1 cfs of firm flow. And that it costs approximately $40 per acre foot for storage in federal projects under consideration. (Presently authorized projects. See appendix for all considered projects.)

The following levels of pollutant** were assumed to be in the stream after treatment and dilution.

SO^{4--}	250 ppm
NO_3^-	90 ppm
B^{+++}	0.3 ppm
Phenol	1.0 ppb
BOD	Removal such that DO of receiving stream will not drop below 5.0 ppm
CL^-	250 ppm

Table III shows the results of applying the above factors to industries presently located in the Kansas basin; no attempt was made to survey all industries, only a representative sample of major industries is shown.

* See Appendix Table II.

** See Appendix Table I.

From this it appears that 1,000 cfs could be worth as much as 3.3 billion dollars annually if used fully for the above purposes. Realizing that maximum development of industry in the Basin with this pattern is not probable, it is of interest that for each 1% of such use, a value of $33,000,000 per year would be apparent.

The water supply aspect of the present Corps of Engineers water control program for the Kansas River Basin in Kansas is estimated to cost about $100,000,000* Comparing this value with the return from a 1% usage of water for industrial development shows that this investment is entirely feasible and desirable for basin economy.

One of the problems peculiar to the Kansas Basin is that of brine pollution from oil field operations. Many wells produce more brine than oil. The oil is recovered and the brine must be discarded. Formerly this brine found its way through natural watercourses into streams. In 1935, the Kansas State Board of Health was given responsibility for protecting surface and subsurface water supplies from activity of the oil industry. The presently favored method of disposal for unwanted brine is to pump it into disposal wells drilled into non-productive zones. No waters are assigned to the duty of diluting salt wastes. However, as some oil fields are produced, it becomes necessary to use artificial means of forcing oil to the wells. One method is through water flooding of the oil producing zone. Brine produced in normal operation then can be used in this water flooding operation. This eliminates the brine from the surface

* See Appendix Table II

and in return produces more oil.

In some areas not enough brine is produced, and fresh water must be used. This is a 100% consumptive use of water as it is permanently removed from the available sources of fresh water. In some areas the percentages of water use for this purpose is as follows:

Fresh Water	1%
Salt Water	80%
Mixed Water (No data on mixture)	19%

Using present values and production ratios, water for this purpose had a value of $1,330,000 per cfs per year. Or 1,000 gallons has a value of $6.80. Referring to previously cited figures, to produce this 1 cfs requires an investment of about $40,000. At present, records show a use of 6.59 cfs for this purpose in an adjoining basin

FUTURE PROJECTIONS.

In the introductory remarks the difficulties of attempting to predict future industrial expansion were noted. Every plant listed in this report has under gone an expansion of some type since initial operation and every one with the possible exception of one is at present either under going or contemplating expansion. Since a large part of the new industry is due to the chemical or inorganic fertilizer field and since in the past no great amount of this material was used in this area, recent increase in the use of these materials due to agricultural research will certainly bring increased use and the necessary plant expansion to produce this material. Greater mechanization of production, agricultural and industrial, will mean greater use of fuels, and therefore, the petroleum producing and refining industries will certainly expand. The production of certain basic materials to be used in the production of the above finished products will have to keep pace with them. Therefore, it appears that a demand exists and will continue to exist for industrial water in the Kansas River Basin.

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APPENDIX DATA

I. U.S.P.H.S. and A.W.W.A. - Chemicals in Drinking Water

II. Cost of Federal Projects.

III. Water Users.

- a. Surface
- b. Ground

IV. Partial List of Industries in Kansas Basin.

V. Sample Calculations.

APPENDIX

TABLE I

Recommended Maximum Concentrations of Various Chemicals in Drinking Water* (USPH S and AWWA)

Substance	Limit, ppm	Common Source	Objections	Remedy
Chemicals commonly found in natural waters:				
Total Solids	1000		Laxative effects	New source
Chloride (cl)	250		" "	" "
Sulfate (SO_4)	250		" "	" "
Nitrate (NO_3)	90**		Infant Cyanosis	Protect source
Flouride (F^9)	1.0**		Mottling of Children's teeth	New Source
Selenium (Se)	0.05		Poison	" "
Hardness (as $CaCO_3$)	100		Soap Consumption	Softening
Magnesium (Mg)	125		Laxative effects	"
Iron and Manganese	0.3		Taste, staining	Treatment
Sodium (Na)	200	Industrial waste. or zeolite softening	Harmful to persons with certain diseases.	Prevent pollution
Turbidity	10	Streams	Esthetic	Filtration, settling
Color	20	Organic matter	"	Treatment
Taste, odor	none		"	"
Chemicals commonly introduced by man's activities:				
Barium	0.0	Industrial waste	Poison	Prevent pollution
Chromium (Cr^6)	0.0	" "	"	" "
Glucosides	0.0	" "	"	" "
Lead (Pb)	0.1	" "	"	" "
Copper (Cu)	3.0	" "	Possible physiological effects	" "
Zinc (Zn)	15	" "	" "	" "
Arsenic	0.05	Fruit Spray	Poison	" "
Phenol	.001	Industrial waste	Taste, odor	" "
pH	10.6	Improper treatment		Correct treatment
Boron**(B)	0.3	Industrial waste	Harmful to Plant life	"

* Revised as shown for this study
** New criteria for this study

APPENDIX

TABLE II

Federal Projects Under Consideration

Reservoir	Water Supply Storage Allocation 1000 a.f.	cost/a.f.	Dollars Water Supply Cost	Firm Yield cfs	Cost/cfs Firm Yield	Yield cfs Ac.Ft.
Tuttle Creek	185	$40	$ 7,400,000	500	$ 14,800	
Milford	300 1/	56	16,800,000	155	108,000	
Perry	100 1/	52	5,200,000	80	65,000	
Kanopolis	162 2/	53 3/	8,600,000	80	107,000	
Wilson	225 2/	29	6,500,000	75	87,000	
Subtotal	972	Ave. 46	44,500,000	890	Ave. 50,000	1 cfs/1090 a.f
Clinton	180	65	11,700,000	73	272,000	
Grove	88	70	6,100,000	23	265,000	
Onaga	90	84	7,600,000	28	271,000	
Camp	67	80	6,300,000	16	331,000	
Humboldt	118	86	10,200,000	29	352,000	
Woodbine	79	62	4,900,000	17	289,000	
Sutphen Mills	148	65	9,600,000	23	417,000	
Turkey Creek	77	76	5,800,000	10	580,000	
Subtotal	847	Ave.73.50	62,200,000	219	Ave. 284,000	1cfs/3860
Total	1819	Ave.$58.60	$106,700,000	1109	Ave. $96,000	1cfs/1640

Notes: 1/ Assumed water supply storage not yet approved.

2/ "Live" conservation storage actually authorized for irrigation.

3/ On basis of 1959 costs rather than actual costs.

* From Kansas Water Resources Board.

APPENDIX

TABLE III a.

(Industrial - Surface)

Name	Drainage Basin		River Mile	Use	Source	Rate c.f.s.	Quantity ac.ft./yr	Location of Diversion Qtr.	Sec	Twp.	Rge.
KP&L	Kans.	Kansas	53.0	Ind.	Surface	44.60	31,795	NE	14	12	19E
Sunflower	do	do	38.0	do	do	93.00	67320	NW	20	12	22E
Ordnance											
KP&L	do	do	75.0-6.0	do	do	113.63	65261.7	Lot3	31	10	17E
Bowersock Mills	do	do	50.5	do	do	2500.00	900,000	at Lawrence			
U.P.R.R.	do	Smoky Hill	169.3-300+	do	do	0.1mgd	36.5mgy	-	6	14	40W
Central Kansas Power	do	S.F.Solomon	169.3-156.1-110	do	do	1.11	400.0	SW	14	8	23W
Stanolind Pipeline	do	Mill Creek-Little Blue	142.5-61.9-25-13	do	do	0.57	34.0	NW	12	3	3E
KP&L	do	Big Blue	142.5-8.1	do	do	28.8	20,000	Lot16,30		9	8E
do	do	do	do	do	do	625.0	215,000	do			
U.P.R.R.	do	do	142.5-82.0	do	do	0.936	110.0	SW	21	2	7E
KP&L	do	do	142.5-80.7	do	do	185.00	22,694.0	NE	29	2	7E
A.T.&S.R.R.	do	Delaware	63.5-25	do	do	0.328	9.0	SW	18	8	18E
Sunflower Co-op Creamery	do	do	do	do	do	1.114	31.0	do			
US Navy Air Station	do	Kill Creek	30.0-10.0	do	do	3.45	307.0	NE	11	14	22E
Franklin Ice Cream Co.	do	Stranger Creek	33.7-10.0	do	do	1.11	260.0	Block 3		11	21E
U.P.R.R.	do	Vermillion	116.9-23.0	do	do	0.267	166.0	NW	35	6	11E
C.R.I.&P.R.R.	do	Mill Creek	101.5-16.0	do	do	300gpm	332 mgy	3	31	11	11E
C.B.&Q.R.R.	do	Beaver Creek	169.3-258.0-12.3-75.0	do	do	0.007	4.6		3	2	31W

Total Acre Feet = 1,323,761.1

Total Use mgd = 1178.108

APPENDIX

TABLE III b.

Industrial Users - Ground Water

Name	Drainage Basin	Use	Source	Rate c.f.s.	Quantity ac.ft./yr.	Location of Diversion Point Qtr.	Sec.	Twp	Rge
KP&L	Kansas River	Ind	Well	1.34	497	NE	14	12	19
Westvaco				3.23	1348	NE	29	12	20
KP&L				1.34	970	NW	14	12	19
do				do	do	do	do	do	do
Coop Farm Chem.				3.35	2419	N	33	13	20
B.L.Anderson,Inc.				3.35	2416	SE	1	12	19
DuPont				5.57	3200	S	29	11	17
ATSF				0.45	40	NE	1	12	23
Sunflower Ord.				15.5	11220	-	19	12	22
Wagego Seed & Elev.				1.11	77	-	4	10	11
UPRR				0.002	0.166	SW	34	9	11
do				0.002	0.114	NW	7	11	7
Coca Cola				3.34	3.07	SE	18	10	8
Manhattan Ice & Gold Stor.				0.646	43.0	SE	18	10	8
Perry Packing				0.111	64.	SE	18	10	8
Wareham Theatre				0.44	18.	SE	18	10	8
UPRR				0.002	0.17	NE	21	10	14
Goodyear Tire				6.24	3833	NE	13	11	15
Beatrice Food Co.				0.93	672	Sw	30	11	15
UPRR				0.46	335	Kaw Half Breed #3			
ATSF				3.09	1841	S	29	11	16
Mutual Ice Co.				1.67	822	SW	29	11	16
Seymour Packing Co.				2.058	1488	SW	29	11	16
Johnson Serum Co.				0.134	16	SW	29	11	16
Railways Ice & Cold Stor.				1.34	745.7	SE	30	11	16
Topeka Fruit Co.				0.067	24.2	SE	30	11	16
Kaw Valley Produce Co.				0.167	91	NE	31	11	16
Hill Packing Co.				1.547	1120	SW	29	12	15
Goodyear Tire				1.56	930	SE	13	11	15
E.A. Sutton				0.36	148	NW	20	11	16
Archer-Daniels-Midland Grain Elev.				0.78	563	SE	16	11	15
Goodyear				1.56	1129	SE	13	11	15
do				15.6	1000	E	13	11	15
Lone Star Cement				0.56	199	SW	28	11	23
ATSF				0.23	0.03	NW	32	11	23
do				0.78	15	SW	28	11	24

APPENDIX

TABLE III b. Cont'd

Name	Drainage Basin	Use	Source	Rate c.f.s.	Quantity ac.ft./yr.	Location of Diversion Qtr.	Sec.	Twp	Rge
Central Packing Co.				1.00	568	SE	10	11	25
KC Dressed Beef Co.				0.89	483	SE	10	11	25
Swift & Co.				5.41	3622	SE	15	11	25
Williams Meat Co.				3.34	141	SE	15	11	25
Proctor & Gamble				6.65	3622	SE	17	11	25
Colgate-Palmolive	Kansas River	Ind.	Well	5.57	798	NW	21	11	25
Standard Rending Co.				0.67	483	NE	22	11	25
Midwest Cold Stor. & Ice				3.56	1513	SW	22	11	25
Proctor & Gamble				6.7	3553	NE	20	11	25
Lone Star Cement				2.0	1252	SW	28	11	23
Colgate-Palmolive				6.70-	3376	NW	21	11	25
KP&L				0.67	480	NW	14	12	19
The following are not listed by the Kansas State Division of Water Resources									
General Motors Corp.				12mgd			Fairfax Ind. Dist.		
Phillips Pet. Co.				4.8mgd				do	
Owens Corning Fiberglass Corp.				3.2mgd				do	
Sunshine Biscuit Co.				2.3mgd				do	
Federal Cold Storage				1.3mgd				do	
Liquid Carbonic Corp.				0.9mgd			East Armourdale Dis		
UPRR	Big Blue			0.002	0.09	SE	33	9	8E
do				0.0246	17.116	-	-	6.7,8	6, 7,8E
do				1.075	44.8	SW	21	2	7E
Certain-Teed Products Corp.				0.114	3	Sw	15	4	7E
do				0.0928	56	NW	21	4	7E
Stanolind Pipeline Co.	Mill Cr.-Little Blue			0.57	34	NW	12	3	3E
do	Little Blue			0.28	3	NE	13	3	3E
St. Joe &G.I.RR				0.054	41	SE	8	2	5E
UPRR	Black Vermillion			0.0624	43	NW	16	4	9E
do				0.0022	1	SE	16	5	10E
Crystal Ice & Fuel Co.	Elk Creek-Delaware			0.89	0.61	-	3	7	15E
ATSF	Rock Creek-Kansas			0.022	0.06	SE	12	10	16E
do	0.022			0.022	0.03	SE	20	9	17E
Sunflower Coop Creamery	Delaware			1.114	31.	SW	18	8	18E
Franklin Ice Cream Co.	Stranger Creek			1.11	260	Blk 3	-	11	21E
Priebe & Sons Creamery	Spring Creek-Delaware			0.256	31	-	35	4	13E
Nemaha Coop Creamery	Webster Creek-Delaware			0.78	138	NW	12	2	14E

TABLE III b. Cont'd

Name	Drainage Basin	Use	Source	Rate c.f.s.	Quantity ac.ft./yr.	Location of Diversion Point Qtr.	Sec.	Twp.	Rge
ATSF	Bury's Creek-Kansas			0.022	0.06	E	24	14	15E
do	Mill Creek-Kansas			0.022	0.06	NW	23	12	10E
do				0.022	0.123	NE	20	13	11E
UPRR	Smoky Hill			0.025	9.125	Nw	2	14	42
UPRR	Solomon			0.003	1.12	NW	7	12	2W
UPRR	Solomon	Ind	Well	0.003	1.12	SE	17	11	3W
do				0.0045	0.34	NW	16	9	4W
Smith Locker Plant				0.11	77.	SE	1	11	4W
Natural Gas & Pipe Line Co.				0.19	123.	SE	7	8	4W
UPRR				0.001	0.08	NW	34	7	6W
do				0.001	0.114	SE	1	8	6
do				0.005	33.	SE	9	7	7
Beloit Coop Creamery				0.006	4.6	NW	9	7	7
Nehi Bottling Co.				0.022	8.	NW	9	7	7
CRI&P	N.Fork Solomon			0.6	460.	-	-	4	18
MOPAC RR				0.008	2.0	-	22	5	13
CRI&P RR				0.06	44.	-	-	3	13
MOPAC RR				0.05	33.	-	28	6	11
UPRR	S.Fork Solomon			0.002	0.08	SW	14	8	24
do				0.02	11.2	SE	14	8	25
do				0.002	0.1	SE	13	8	26
do				0.002	0.08	SE	19	8	29
do				0.1	112.	SE	13	8	31
do				0.002	0.083	-	11	8	32
do				0.002	0.083	SW	21	9	20
Kansas-Nebraska Nat. Gas.Co.				0.0011	0.43	NW	23	7	18
do				0.03	4.8	NE	5	8	32
UPRR	Republican			0.015	0.08	SE	19	10	5E
do				0.015	0.08	SW	13	11	4E
Belleville Bottling Co.	Salt Creek-Repl.			0.05	3.0	SE	3	3	3W
CRI&P RR	Republican			0.06	46.	-	32	4	5W
Northern Nat.Gas				0.23	115.	NW	1	6	1E
UPRR				0.018	0.08	SE	13	8	1E
Clay Center Ice Co.				0.11	77.	In Clay Center			
Coca Cola Bottling Co.				0.13	15.	do			
City of Clay Center				2.67	1902.	NE	7	8	3E
UPRR				0.018	0.08	NW	36	8	3E
Western Light & Tele. Co.				1.11	803.	SW	28	5	3

TABLE III b. Cont'd

Name	Drainage Basin	Use	Source	Rate c.f.s.	Quantity Ac.ft./yr.	Location of Diversion Point Qtr.	Sec.	Twp.	Rg
Concordia Ice Co.				0.16	107.	In Concordia			
Seymour Packing Co.				0.66	31.	do			
MOPAC RR				0.28	14	SE	22	5	5
Western Light & Tele.				0.44	322	NW	33	5	3W
CB&Q RR				0.016	120	SE	21	3	40
do	Beaver Creep-Rep.			0.007	4.6	SE	20	3	36
do	Prairie Dog Creek-Rep.			0.006-	4.4	NW	36	2	26
State TB San.	do			1.10	184.	NE	32	2	22
CRI&P RR	Prairie Dog Creek-Rep.								
		Ind	Well	0.077	77.0	NW	3	3	23
CB&Q RR				0.006	42.	SE	23	1	20
CRI&P RR				0.077	55.		In Selden		
do				0.077	55.		In Colby		
Central Kansas Power Co.				0.67	483	NE	31	7	33
Oberlin Ice and Storage	Sappa Creek-Rep.			0.07	31		In Oberlin		
Goodland Rending Co.				0.16	46	SW	22	8	39
O.K. Packing Co.				0.11	9	SW	18	8	39
Garrison Inc.				0.15	74		In Goodland		
Commonwealth Theatres, Inc.				0.44	34	-	19	8	39
CRI&P RR				0.309	224	-	19	8	39

TOTAL: Acre Feet/year = 73,356.074

Million gallons/day = 65.5

APPENDIX

TABLE IV

PARTIAL LIST OF INDUSTRIES IN THE KANSAS RIVER BASIN BELOW JUNCTION CITY, KANSAS

City and Industry	Waste Population Equivalent	Treatment	Discharge to	Remarks
Alma				
Alma Cheese Co.	260		City sewer	
Bonner Springs				
Lone Star Cement Co	205	Septic tank & Filter	Wolf Creek	Stone & cement dust to creek
Millstream Cereal Co	1260		City sewer	
Rice Sausage Co	290		do	
Richardson Co	110		do	
DeSoto				
Atkinson Locker Plant	220	none	Dry Trib.	
Eudora				
Bichelmeyer Locker	540		City sewer	
Everest				
Sunflower Coop Cream.	1000	none	Dry Trib.	Under investigation.
Frankfort				
Tuckers Market	150		City sewer	
Greenleaf				
Locker Plant	?		City sewer	
Holton				
Holton Locker Co.	590		City sewer	
Alley & Duffey Locker	490		do	
Horton				
Horton Locker Co	400		City sewer	
Priebe & son(Poultry)	340		do	
Tuliks Market	180		do	
Whiting Cheese Plant	?		do	
Kansas City				
Armour & Co.	215,000	none	Kansas River	Even is these discharge to the city sewers, there is no treatment at Kansas City.
Cudahy Packing	150,000	do	do	
Eldridge Packing	5,000	do	do	
Geo.Kaiser Packing	15,000	do	do	
KC Dressed Beef Co	10,000	do	do	
Mauer-Neuer Co.	12,000	do	do	
Sambol Packing Co.	3,500	do	do	
Swift & Co.	250,000	do	do	
US Packing Co	?	do	do	
Wilson & Co.	38,000	do	do	
Central Packing Co.	26,000	do	K.C. Sewers	
Bickelmeyer Slaughter	870	do	do	
Kaw Valley Packing	2400	do	do	

City and Industry	Waste Population equivalent	Treatment	Discharge to	Remarks
Kansas City Cont'd				
W.A. Mathes Meat Mkt.	390	none	K.C. Sewers	Even if there
M&E Packing Co.	770	do	do	
Rayan Packing Co.	230	do	do	
Grain Valley Meat & Sausage Co.	100	do	do	
Malco Meat Prod.	100	do	do	
Meyer Sanitary Milk Co.	1600	do	do	
Kelly Cooperage Co.	500*	do	Kansas River	*10,000 gal. caustic
Sims Barrel Co.	250*	do	do	*3,000 gal. Caustic
Penn Central Cooperage	100*	do	do	*1,000 gal. Caustic
Alvine Dairy	200	do	do	
Wyandotte Commissary	195	do	K.C. Sewers	
Kansas Fish & Oyster Co.	425	do	do	
Central Produce	250	do	do	
Car Offer Produce	610	do	do	
Dated Egg Co.	490	do	do	
Dobson House	250	do	do	
Babich Produce	150	do	do	
Buick-Oldsmobile-Pontiac	?	?	do	Welding & Plating Wastes
Decoursey Creamery Co.	200	none	do	
Consolidated Produce	2000	do	do	
Milk Producers Mkt.Co.	1000	do	do	
Forsen Dairy	150	do	do	
Prairie Breul Bottling Co.	300	do	do	
Firesids Marshmallow Co.	200	do	do	
American Battery Co	100*	do	do	*Also H_2SO_4
Proctor & Gamble	47,000	do	Komes River	
National Cylinder Gas	-	do	do	
Midwest Cold Storage	-	do	do	
Stockyards Co.	-	do	do	
AT&SF RR	-	do	do	
Missouri Valley Serum Co.	-	do	do	
Peerless Serum Co.	2400	do	do	
National Labratory Co.	3600	do	do	
Colgate-Palmolive-Peet	17000	do	K.C. Sewers	
Home Laundry	2,000	do	do	
Wyandotte Laundry	1,000	do	do	
Central Laundry	2,500	do	do	
Serv. Indust. Clean.	2500	do	do	
Baska Laundry	1000	do	do	
Peters Serum Co.	1000	do	do	
Guilfoil Serum Co.	1000	do	do	
Missouri Valley Serum Co.	1000	do	do	
Socony-Vacuum Oil Co.	*	do	do	*15,000 Gal.caustic
Uhlman Grain Co.	-	do	do	
Continental Baking Co.	-	do	do	
C.R.I.&P.R.R.	-	do	do	

City and Industry	Waste Population equivalent	Treatment	Discharge To	Remarks
Kansas City Cont'd				
Simonds,Shields, & Thies	-	none	K. C. Sewers	
M.K.T.R.R.	-	do	do	
Bush Plating Co.	-	do	do	Metal Plating Wastes
Union Pacific RR	-	do	do	
Sunshine Biscuit Co.	2000	do	do	
Fetters Bros.Rendering	250	do	do	
O.V. Sanitary Egg Co.	-	do	do	
Standard Rendering Co	720	do	do	
James Street Grease Salvage	-	do	do	
Sinclair Petroleum Co.	7200	do	Kansas River	
Lawrence				
Coop Farm Chemical	?	equal. pond	do	Tank & filter for employee wastes
Fritzel Jayhawk Dairy	370		city sewer	
Lawrence Egg & Poultry	500		do	
Lawrence Paper Co.	5000*	Temp.Plant	Kansas River*	40,000 sus.solids
Sanitary Milk Co.	600	*	City sewer	*Some to Kansas River
Southside Produce	130		do	
Stokley Foods inc.	6500		do	
Westvaco Chemical Co.	?	none?	Kansas River	
Callery Chemical Co.	?	equal.ponds	do*	*Boron wastes, some wastes to city sewer
McFarland				
C.R.I.&P.R.R.	-	none	Mill Creek	Oil spills to creek
Manhattan				
Chappell Creamery	220		city sewer	
City Dairy	370		do	
KSU Creamery	200		do	
Manhattan Creamery	220		do	
Viking Co.	-		do	Farm Mach.Manu.
Olathe			city sewer**	
Delco-Remy Battery	-	Lime Neutral*	Cedar creek	**Collodial clay problem. *Also equal.pond Operational difficulties acid wastes only.
St. Mary's				
Woods Slaughterhouse	380		City sewer	
Health Chick Hatchery	-		do	

City and Industry	Waste Population equivalent	Treatment	Discharge to	Remarks
Sabetha				
Nemaha Co.Coop Milk Plant	4000		city sewer	City plant overloaded
Sunflower Ordnance Plant	15000 employees at peak prod.	Neutral.tank	Kill Creek	Acid waste
Tonganoxie				
Frozen Food Locker	900		city sewer	
Topeka				
Hill Packing Co	?		do	
Seymour Packing	?		do	
Goodyear Tire &Rubber	1800	Mech aeration	Soldier Creek	Soap Wastes
A.T.&S.F.R.R.	-		Kansas River	
Valley Falls				
McLeod Packing Co.	100		city sewer	
Sunflower Creamery,Assoc.	1,000		do	
Washington				
Locker plant	-		do	

PARTIAL LIST OF INDUSTRIES IN THE KANSAS BASIN [redacted] JUNCTION CITY, KANSAS

City and Industry	Products	Remarks
Abilene		
Belle Springs Creamery	Butter, eggs, ice, poultry	
Houlton Packing Co.	Meat packing, cold meats	
Kansas Power & Light	Power generation	
Royal Crown Bottling Co.	Soft drinks	
Alton		
Oliva Mfg. Co.	Small machine parts	
Triple G Mfg. Co.	T. V. towers	
Arnold		
North Welding Co.	Chaff raisers, car coolers	
Atwood		
Central Kansas Power Co.	Power generation	
Sunbonnet Mfg. Co.	Ladies hats	
Barnard		
Griffith Provision Co.	Meat processing	
Belleville		
Belle Crest Dairy	Milk	
Belleville Ice Plant	Ice, ice cream	
Belleville Locker & Processing Co.,Inc.	Meats, vegetables	
Christie Hatchery	Chicks	
Hotchkiss Concrete & Materials Co.	Sand, concrete, and concrete blocks	
Spangler Insulation & Mfg. Co.	Insulation, storm windows	
Weaver Rendering Co.	Meat scraps	50 P.E. as discharged
Beloit		
Beloit Concrete Products	Concrete, sand, blocks	
Beloit Dairy Products	Butter, milk, ice cream	
Mastercraft Upholstery	Awnings, draperies	
Rustman Hatchery	Chicks	
Sunflower Mfg. Co.	Soil packers, plow bearings	
Wesselowski Hatchery	Chicks	
Bird City		
B & A Mfg. Co.	Tire truing machine	
Blue Rapids		
Bestwall Gypsum Co.	Plaster, wall board materials	
Blue Rapids Supply Co.	Rubber molds, plastercraft supplies, campground guide	
Blue River Sand & Gravel	Concrete aggregates	
Haller Sales & Mfg. Co.	T. V. antennae	
Markley's Hatchery	Chicks	
Cawker City		
The Barnett Co.	Plastic covered furniture	
Coad Saddlery	Leather goods	
Richardson Mfg. Co.	Specialized farm machinery	

City and Industry	Products	Remarks
Clay Center		
Clay Center Concrete & Sand Co.	Concrete products	
Coca Cola Bottling Works	Soft drinks	
Erickson Building Supply, Inc.	Millwork	
Fellers Dairy Co.	Cheese, ice cream, milk	
Fincham Locker	Meat products	
Guyer- Gilmore Mfg. Co., Inc.	Metal fabrication	
Kohlmeyer Hatchery & Broiler Plant	Poultry	
Riddle Quarries, Inc.	Limestone products	
Clifton		
Geo. Cox & Sons	Irrigation systems	
Colby		
Browns Cabinet Shop	Millwork	
Central Kansas Power Co.	Power generation	
Colby Locker	Meat processing	
Colby Mattress Co.	Mattresses, furniture	
Colby Supply & Mfg. Co.	Canvas products	
Reed Mfg. Co.	Metal fabrication	
Concordia		
The Beatrice Foods Co.	Butter, cheese, milk	
Bolls Dairy	Ice cream, cheese	
Cloud Ceramics	Brick	
Dodson Mfg. Co.	Silos	
Fairmount Foods Co.	Butter, cheese, milk	
Grandpre Shop	Metal fabrication and plating	
Delmer F. Harris Co.	Playground equipment	
Peltier Foundry	Structural steel fabrication	
Ross Sand Co.	Sand, gravel, concrete	
Seymour Food, Inc.	Poultry, frozen eggs	
Western Light & Telephone	Power generation	
Courtland		
Blackburn Produce Co.	Eggs	
Downs		
Downs Mfg. Co.	Metal fabrication	
Reid Sign Co.	Metal & neon signs	
Edson		
National Lead Co.	Diatomaceous earth	
Ellis		
Ellis Rendering Co.	Meat scrap processing	
Union Pacific Railroad	Shops, refueling	
Ellsworth		
John Burke	Metal fabrication	
Emmett		
Luttig Trailer Co.	Heavy metal fabrication	
Enterprise		
The J. B. Ehrsam & Sons Mfg. Co.	Metal casting and fabrication	
Riddle Quarries	Limestone products	

City and Industry	Product	Remarks
Glasco		
Glasco Locker Plant	Meat processing	
Goodland		
Allison Hide & Rendering Co.	Meat scraps and tallow	
Burkett Dairy	Dairy products	
Coca Cola Bottling Co.	Soft drinks	
Goodland Hatchery	Chicks	
O. K. Packing Co.	Meat processing	
Schetzer Mfg. Co.	Automobile accessories	
Tyron Mfg. Co.	Tire repair supplies	
Gove City		
Litson Leathers	Leather products	
Grinnell		
Dorothy Van's Gift & Ceramics	Ceramic materials	
Hanover		
Bohnings Saw Mill	Lumber	
Hanover Implement Co.	Metal fabrication	
Albert Meyers	Ceramics	
Novel Woodcraft	Furniture	
Hays		
The Central Kansas Power Co.	Power generation	
Engel Electric Hatchery	Chicks	
Hays City Flour Mills	Flour, feed	
Hays Coca Cola Bottling Co.	Soft drinks	
Hays Creamery Co.	Ice cream	
Hays Planihg Mill	Furniture	
Higher View Dairy	Dairy products	
Kansas Natural Stone Co.	Cut stone and carvings	
The L. K. Dairy	Cheese, butter, milk	
Seven-Up Bottling Co.	Soft drinks	
X. L. Potato Chip Factory	Potato chips	
Hill City		
E. & J. Dairy	Dairy products	
Phillips Slaughter House	Meat products	
Salco Co., Inc.	Impervious lining for sealed brine ponds	
Hope		
Davis Feeding Units	Poultry supplies	
Hope Creamery Co.	Butter, meats	
Junction City		
City Ice Co.	Ice cream, ice	
Coca Cola Bottling Co.	Soft drinks	
Concrete Products Co.	Concrete building units	
DeForest Hatchery & Poultry Farm	Chicks, poultry	
JoMar Dairies	Ice cream, butter	
Junction City Stone Co.	Cut stone	
Spudette Potato Chip Co.	Potato chips, popcorn	
Walker Cut Stone Co.	Cut stone	
Weside Dairy, Inc.	Ice cream, cheese, milk	

City and Industry	Product	Remarks
Kanopolis		
Great Bend Brick & Tile Co.,Inc.	Brick, sewer pipe, flue liners	
Independent Salt Co.	Mining of salt	
Kensington		
Hainke Mfg. Co.	Lawn mowers, stock tank heaters	
Lincoln		
Quartzite Stone Co.	Concrete products, filter stone	
Lindsborg		
Bachman Ice Cream Co.	Milk, cream, ice cream	
Davis Coffee House	Coffee bean roasting and blending	
Lungstrom Machine & Mfg. Co.	Porcelain tube cutters, pipe wrapper	
Anton Pearson	Wood products	
Weide Bros.	Ice	
Linn		
Washington County Coop Creamery Co.	Butter, poultry, eggs	
Marysville		
Blue Valley Ferilizer Co., Inc.	Commercial fertilizer	
The Handy Bindery	Book binding	
The Kansas Power & Light Co.	Power generation	
Kohlmeyer Hatchery	Chicks	
Lake's Silver Dollar Turkey Farm and Hatchery	Turkeys	
Latta Dental Laboratory	Dentures	
Mak's Marysville Hatchery	Chicks	
Marysville Coca Cola Bottling Co.	Soft drinks	
Marysville Ice Co.	Ice	
Pepsi-Cola Bottling Co.	Soft drinks	
Rogers Mfg. Co.	Metal fabrication	
Seymour Foods, Inc.	Poultry, shell and frozen eggs	
Morganville		
Nelson Hennery & Hatchery	Chicks	
Oetinger Bros. Locker Plant	Meat products	
Natoma		
Krueger Mfg. Co.	Grain loaders, power mowers	
Norton		
Fairmount Food Co.	Butter, ice cream	
Jay's Woodwork Shop	Furniture	
Norton Coca Cola Bottling Co.	Soft drinks	
Norton Ice & Locker Service	Ice, meat processing	100 P.E. as discharged to stream
United Dairies Products	Cheese, buttermilk, milk	
Wyandotte Chemical Corp.	Volcanic ash	
Oberlin		
Pepsi-Cola Bottling Co.	Soft drinks	
Osborne		
Michaelis Millwork Co., Inc.	Millwork	

City and Industry	Product	Remarks
Phillipsburg		
Bear Brand Roofing, Inc.	Asphalt roofing materials	
Coop Refinery Assoc.	Petroleum refining	1500 P.E. as discharged to stream
Phillipsburg Sash & Door	Millwork	
Plainville		
Central Machine Works	Oil field tools	
Riley		
Anderson Hatchery	Chicks	
Art's Machine Shop	Specialized tools	
Russell		
City Dairy	Ice cream, cheese, buttermilk	
Dietz Slaughter & Processing Plant	Meat processing	
Quima Dairy	Milk, buttermilk, cheese	
Russell Building Stone, Inc.	Cut stone	
Russell Ice & Locker	Ice	
St. Francis		
Goodell Mfg. Co.	Aluminum foundry	
Salina		
Anderson Leather Shop	Leather goods	
Applequist Tool & Machine Shop	Contract Manufacturing	
Beverly Wholesale Meat Co.	Meat products	
The Central Cabinet & Fixture Co.	Furniture and millwork	
DeCoursey Ice Cream Co.	Dairy products	
Dr. Pepper-Seven-Up Bottling Co.	Soft drinks	
E. K. Dental Laboratory	Dental supplies	
Elmore Dairy	Ice cream, cheese, milk, cream	
Great Western Hatchery	Chicks and turkey poults	
Hale's Potato Chip Co.	Potato chips	
Harding Cream Co.	Butter	
The JoMar Dairies Co.	Butter, ice cream, milk	
Lowe's Poultry & Sporting Goods	Poultry and sporting goods	
Mc Cune Paper Box Co.	Paper boxes	
Mehi-Royal Crown Co.	Soft drinks	
Pepsi Cola Bottling Co.	Soft drinks	
Roberts Mfg. Co.	Metal bearings	
Coca Cola Bottling Corp.	Soft drinks	
Salina Coffee House	Coffee bean roasting and blending	
Salina Mfg. Co.	Heavy metal fabrication	
Salina Poultry Co.	Eggs, dressed poultry	
Saline Valley Hatchery	Chicks	
Strahan Creamery Co.	Butter, ice cream	
Swift & Co.	Butter, poultry, shell eggs	
Tanner Feed & Hatchery	Feed, chicks	
Western Ice Co.	Ice	
Wyatt Mfg. Co.	Metal casting and fabrication	
Smith Center		
Bestyet Ice Cream, Inc.	Ice cream	
Edell Creamery Co.	Butter, ice cream, milk	
Mini-Max Provisions, Inc.	Ice cream, milk	

City and Industry	Product	Remarks
Tescott		
Tescott Cheese Co.	Cheese	
McKenney		
Lubri-Gel Products Mfg. Co.	Drilling mud	
Wilson		
Klema Poultry & Dairy	Eggs	
Miller Packing Co.	Meat processing	

APPENDIX V

SAMPLE CALCULATIONS

I. Plant Water Intake Value.

Ex: Goodyear Tire and Rubber Co., Topeka, Kansas.
1900 employees.
$400,000,000 Value shipped annually.
$200,000,000 Value added in basin annually.
14,000,000 annual payroll.
(Above data from Kansas Industrial Development Files).

15,829 Ac. ft. water demand per year. (From Division of Water Resources, Kansas State Board of Agriculture.)

then: $200,000,00/15,829 = $12,600 added value per ac. ft. diverted.

$5,358 = national average for water use value ratio of Kansas value to national = $12,600/5,358 = 2.35.

This value is based on a water right and not actual use. The actual use in this case was 3250 ac. ft. so values would be adjusted as shown in Table II.

II. Waste Water Demand

1. Ex: Coop Farm Chemicals, Lawrence, Kansas.
$5,000,000 value added in basin annually.
Waste produced 0.60 Ton/day NO_3^- ion.

Present water quality 5.0 ppm NO_3^- ion.

To dilute 1 ton to 90 ppm with water at 5 ppm will take 4.3 cfs. To produce an income of $5,000,000/year means 0.60 Ton/day of water ion, so 0.6 x 4.3 = 2.58 cfs of diluting water. 5,000,000/2.58 = $1,940,000 of value added per cfs demanded for dilution.

To produce 2.58 cfs will require approximately 2.58 x 1000 = 2580 ac ft. of storage.

If storage is worth $40/ac. ft. then an investment of $155,000.

2. Ex: Oil Well Repressuring and Salt Water.

Disposal Operations in Kansas.

A survey of 14 operations in Eastern Kansas showed that the amount of water injected to produce a barrel of oil varied from 3 to 22 barrels. The mean value was 10 bbl. of water to produce 1 bbl. of oil.

If oil is worth $2.85 per 42 gal. barrel, then the maximum value of water to produce it would be 2.85/ 10 x 42 = $0.0068 per gal. or a water value of $7.10/1000 gal.

Records show that 97,438 bbls. of water were used per day. This would produce 9744 bbls. of oil per day with a value of 27,700.

On a yearly basis then: -

27,700 x 300 = $8,325,000 Annually.

The flow to produce this is equal to 6.6 cfs or 8,325,000/ 6.6 = $1,260,000 / cfs/ year.

To produce 1 cfs. requires 1,000 ac. ft. of storage at $40 ac. ft. or 6.6 x 1,000 x 40 = $264,000.